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A REVIEW OF CURRENT IDEAS ON THE TEACHING OF MATHEMATICS[1]

THE subject of elementary mathematics has been the last to respond to improved pedagogical methods. Recently, however, there has been a general awakening of interest in methods of mathematical instruction which seems to be universal in its scope, and to have originated simultaneously in France, Germany, England and the United States. Although the discussions have been widely varied, there is practical unanimity on the point that mathematical instruction should be less formal and more practical, and should constitute simply an extension of the ordinary experience of the child.

Although the ideas recently expressed are almost wholly deductions from experience, they seem, for the most part, to have a scientific basis. They recognize, namely, that the child learns as the race has learned, by proceeding from concrete and familiar facts to the general laws underlying all

[1] A summary of reports on special topics, assigned in connection with a course for teachers on the history and teaching of mathematics, given by Professor S. E. Slocum at the University of Cincinnati, 1907–8. The class, part of whose work is here presented, was composed as follows: Charles Otterman, A.B., professor of mathematics, Woodward High School, Cincinnati, Ohio; Albert Schwartz, A.B., principal Linwood School and principal East Night High School, Cincinnati, Ohio; Benjamin H. Siehl, A.B., teacher eighth grade, Morgan School, Cincinnati, Ohio; Charles H. Siehl, A.B., teacher eighth grade, Garfield School, Cincinnati, Ohio; Jesse K. Dunn, principal Highlands School, Cincinnati, Ohio; F. L. Williams, A.M., principal William Grant High School, Covington, Kentucky; Howard Hollenbach, B.Sc., instructor in science, Lockland High School, Lockland, Ohio.

experience. The historical parallel, in fact, is strikingly manifest in the form, content and sequence of development of elementary mathematics as proposed in these reforms.

GERMAN REFORMS[2]

The nineteenth century may be divided into three periods as regards the form and content of mathematical instruction in Germany. In the first period, extending from 1800 to 1870, mathematical instruction was a mixture of the pure and applied. Ideals were high, efforts were directed toward awakening individual ability, and attempts were made to teach more than is required at present. The candidate for the position of teacher of mathematics must be a specialist capable of original investigation, and as a result we find such names as Grassmann, Kummer, Plucker, Weierstrass and Schellbach.

The opening of the second period, 1870–1890, was signalized by the victory over France, and the assumption by Germany of a more important international position. This period was marked by a separation of pure and applied mathematics. In the schools the feeling prevailed that the development of the especially gifted pupil was not to be sought so much as that of the average pupil, and consequently greater interest was manifested in the method of instruction. Instead of the early system, a desire was expressed for a systematic graded course in mathematics, keeping in view the ability of the constantly developing pupil. Drawings and models were demanded, problems were so stated and aids so given that the pupil might see space relations and not depend so largely on the logic of the ancient Greeks. This was a direct result of the teachings of Pestalozzi and Herbart. In this period the standard for teachers was lowered, and there was only required a knowledge sufficient to solve problems of moderate difficulty.

The third period, beginning with 1890, seems to be characterized by a tendency to again associate pure and applied mathematics. That is to say, a teacher is required to be thoroughly familiar with pure mathematics and at the same time to have an extensive knowledge of its applications.

For many decades the value of mathematical training was thought to lie in its formal discipline. Before the revival of learning it was the utilitarian factor which was emphasized, while in the last few decades the majority have reached a more comprehensive notion. Recently Professor Felix Klein, the greatest of living German mathematicians, has shown a deep interest in the problems of the schools, and has taken an active part in their discussion. His views are typical of modern German scholarship, and form the basis of the reforms instituted and proposed.[3]

According to Professor Klein, mathematical thought should be cherished in the schools in its fullest independence, its content being regulated in a measure by the other problems of the school; in other words, its content should be such as to establish the liveliest possible connection with the various parts of the general culture which is typical of the school in question. Here, then, it is not a question of the method of teaching, but rather of the selection of material from the great mass furnished by elementary mathematics.

Much of the material of instruction, although interesting in itself, lacks connection and is wholly or partially isolated, thus affording only a faulty and indirect

[2] For a more detailed account, see article by Charles Otterman entitled "A Review of Klein's Attitude on the Teaching of Mathematics," Science, September 13, 1908.

[3] "Neue Beiträge zur Frage des Mathematischen und Physikalischen Unterrichts an den Hoheren Schulen," Klein und Riecke, Teubner, 1904.

preparation for a clear understanding of the mathematical element of modern culture. This element clearly rests on the idea of function, both geometrical and analytical, and this idea should be made the center of mathematical instruction. In fact, Klein's chief thesis is that beginning with the Untersecunda and continuing in regular methodical steps, the geometrical conception of a function should permeate all mathematical instruction. In this is included the consideration of analytic geometry and the elements of differential and integral calculus.

The ground to be covered depends largely upon the ideal of the school. While the formal side must not be overlooked, and a thorough knowledge of the processes must be obtained, the principal aim should be to give a clear conception of the fundamental ideas and their meaning.

Mathematical instruction on the level at which it is carried on in the upper classes of the higher schools has existed in Germany since about the beginning of the eighteenth century. In this early formative period calculus was not considered elementary, for it was the possession of only a few investigators of the highest type. Cauchy's great work on differential and integral calculus appeared in 1821, but the schools had already been led into certain channels, and it was not possible to divert them toward a subject which was only in the process of formation. In fact, calculus was considered as a sort of witchcraft, and has ever since been regarded with suspicion.

The official course of study of 1900, however, showed a tendency in the opposite direction, so that Klein believes that advantage should be taken of this favorable attitude to place that which has taken centuries for preparation upon a generally recognized basis.

As a matter of fact, the ideas underlying the calculus are actually taught in many schools. In a few Ober Real schools they are regularly taught as calculus, but in the majority of schools they are taught in the most round-about manner. In fact, students are actually taught to differentiate and integrate as soon as occasion for the same arises, but the terms differential and integral are avoided.

Klein's opinion is that instead of making instruction in calculus in those grades whose work demands its employment incidental, desultory and generally unsatisfactory, it should be made the central idea of instruction, and the other ideas and work grouped around it. At present, calculus is made the beginning of higher mathematics and is accompanied by a revolution in thinking. Klein's suggestions aim to obviate this difficulty by gradually accustoming the pupil to those methods of thinking which later predominate.

THE PRUSSIAN SYSTEM

The Prussian schools are probably the most efficient, in point of actual instruction, of the entire German school system, and for this reason deserve special consideration.

Although but 1.2 years of the nine school years are given to mathematics as compared with 2.1 years in this country, the Prussians accomplish fully as much as, if not more than, our American schools, with a saving of .9 of a year, or .1 of the total time of instruction for the nine years.

The three main causes of the excellence of the Prussian work in mathematics are the central legislation and supervision, the thorough preparation of the teachers and the systematic methods of instruction. Each of these is a result of the preceding; for well-prepared teachers are likely to use good methods of instruction and the thorough preparation of teachers is sure to be

required when the legislative and executive authority is vested in experienced educators of the highest order. It might be sufficient to say that the strength of the Prussian system is due to the fact that for two thirds of a century the work has been centered in a single source of authority for the entire kingdom.

In American schools considerable loss is due to the fact that during the nine years which correspond to the German Gymnasium, every pupil must make two changes, viz., from the grades to the high school and thence to college. The work of these nine years is thus carried on under different circumstances, with different names and methods, and under teachers differing in their preparation; and instruction necessarily suffers in consequence.

The Germans appreciate the fact that the teacher can do his best only in an atmosphere of financial and mental tranquility, and while insisting on high standards and severe tests at the outset, assure a tranquil career to those who have given evidence of their fitness, by a regular system of promotions and pensions.

In the common schools, the aim is to train good and faithful citizens, the process being called "Erziehung" (bringing up).

In the higher schools, the aim is to impart learning, and to turn out educated and cultured men. The process is called "Unterricht" (instruction), and leads to privileges and responsibilities before the civil and military law. Attendance upon the common schools is regarded as the duty of those not having better opportunities and is enforced by the state, whereas attendance upon a higher school is considered a privilege and the state may restrict the number of persons admitted.

The work in mathematics done in the higher schools covers practically the same ground as our course to the close of the freshman year in college. The general aim of the instruction is facility of calculation with numerical quantities and their application to the usual circumstances of everyday life, algebra to quadratics, plane and solid geometry, plane trigonometry, the idea of coordinates and some of the fundamental properties of conic sections. In all of these subjects an effort is made to impart an intelligent knowledge of the theorems, as well as skill and facility in their application.

The entire mathematical education of the boy from the elements of arithmetic to those of analytic geometry takes place in one institution under one management guided by the close supervision of the same director and under the tuition of men of the same scientific training, who are colleagues, working in close contact, with opportunities for intimate interchange of ideas.

The aim of the teaching of arithmetic is to secure facility in operations with numbers. In order that it may be in harmony with the following algebraic instruction, and prepare for it, the reviews of the fundamental operations and the treatment of fractions is based upon mathematical form, and the handling of parentheses is continually practised. In fractions the pupil is taught to operate with fractional parts as concrete things, and facility in computation is maintained by continued numerical exercises in the algebraic instruction in the following classes.[4]

In the Real Gymnasium the scope of instruction in algebra includes the proof of the binomial theorem, and the solution of equations of the third degree; plane geometry, including the theory of harmonic points and pencils and axes of symmetry;

[4] For a description of courses see "The Teaching of Mathematics in the Higher Schools of Prussia," J. W. A. Young, Longmans, 1900.

solid geometry, and the elements of descriptive geometry; plane and spherical trigonometry; introduction to the theory of maxima and minima; plane analytic geometry.

In addition to this the Oberrealschule requires the most important parts of algebraic analysis. Equations of the fourth degree, and the approximate numerical solution of algebraic and transcendental equations may be taken up at the option of the instructor. In all these topics the aim is to give practise in the application of the theorems, as well as to lead to a mastery of the proofs. Considerable stress is also laid upon the oral solution of easy exercises.

The German higher school system speaks with no uncertain tone of the practical advantage of beginning both algebra and geometry early; and continuing their study simultaneously through a number of years.

The method of instruction in Prussia may be styled the genetic method in that it does not require any previous preparation of the pupil for the work of the hour. The quantity of home work is kept as small as possible, and material that has not been thoroughly explained in the class is never assigned to be studied privately by the pupil. A text-book is officially required but is seldom used, and at most the pupil is only referred to it after class treatment, and not before. The genetic method has been but little used in America, but there is a strong trend toward the use of the heuristic method, which is somewhat similar. It resembles the genetic method in its marked effort to keep the pupil thinking for himself, but differs from it in that the class is the working unit in the genetic method, whereas the pupil is the unit in the heuristic method. This difference may be said to be characteristic of the German and American methods of mathematical instruction. In Germany the class works as a whole under the guidance of an instructor. In America the individual pupil demonstrates, explains and asks and answers questions, while the others listen to him.

While the results of the genetic system as applied to the Prussian schools amply justify its use with German pupils, it by no means follows that the method is of universal application, and could be used to advantage in this or other countries. The other features of the German school system, however, relating to the high standard of technical excellence in the teaching profession, and the correlation and continuity of instruction, are of the deepest and most general pedagogical significance.

ENGLISH REFORMS: THE PERRY MOVEMENT

The English reforms are largely based on the so-called "Perry movement," which originated from a paper on the teaching of mathematics read by Professor John Perry at a meeting of the British Association in Glasgow in 1901.[5] In this paper Professor Perry maintained that *usefulness* should be the criterion for determining what subjects should be taught to children, and in what way they should be taught.

The present methods of teaching mathematics keep students so long upon the knowledge already organized that there is neither time nor enthusiasm for undiscovered fields. Absolute correctness and philosophical insight receive too much attention in the teaching of elementary subjects. For example: the first four books of Euclid might be assumed, or accepted partly by faith and partly by trial, and the sixth book regarded as axiomatic. In this way the student might begin his work earlier and much more be accomplished. What is

[5] "Discussion on the Teaching of Mathematics," edited by Professor Perry. British Association Meeting, Glasgow, 1901. Macmillan, 1902.

omitted would be compensated for by an increase in youthful enthusiasm and the development of individuality and inventiveness.

It is well recognized that the study of natural science is essential to all courses of study. Such study, however, is impossible without a practical, working knowledge of mathematics, and facility in its application to problems in engineering and general science. The elementary study of nature requires skill in computing with logarithms; knowledge of, and power to manipulate, algebraic formulas; the use of squared paper, and the methods of the calculus. Professor Perry believes that boys may not only become skilful in the use of these instruments, but will learn them with pleasure. He also asserts that the men who are teaching orthodox mathematics are not only destroying what power to think exists, but are also producing a dislike and hatred for all kinds of computations, and, therefore, for all scientific studies of nature.

As the basis of his belief that instruction in elementary mathematics should be made more practical, Professor Perry states that

> In the whole history of the world there was never a race with less liking for abstract reasoning than the Anglo-Saxon. Every other race has perfected abstract schemes of government. Here common-sense and compromise are believed in; logical deductions from philosophical principles are looked upon with suspicion not only by legislators but by all our most learned professional men.

All of this indicates that philosophy is certainly not intended for children. This was also the view of the ancient Greeks, who held that only a few men were capable of philosophic insight. Reading, writing and ciphering were at one time regarded as learned studies. However, when they became essential to the correct doing of one's daily work, they were taught quite readily to children without unnecessary philosophy. So the child should learn mathematics without unnecessary philosophy. Omitting this philosophic insight, the average boy may learn much useful mathematics which will serve him all through his life.

Professor Perry's plan lays emphasis upon the following propositions: (1) Experimental methods in mensuration and geometry ought to precede demonstrative geometry, although even in the earliest stages some demonstrative reasoning may be introduced. (2) The experimental methods adopted may be left largely to the teacher. (3) Decimals ought to be used in arithmetic from the beginning. (4) The numerical solution of complex mathematical expressions may be taken up almost as a part of arithmetic, or the beginning of algebra, as it is useful in familiarizing pupils with the meaning of mathematical symbols. (5) Logarithms should immediately follow the theory of exponents. (6) The study of the calculus may precede advanced algebra, advanced trigonometry, or analytical geometry, and may be illustrated by any quantitative study in which the pupil may be engaged.

The course in elementary mathematics suggested by Professor Perry includes the following:

In arithmetic, the use of decimals from the outset; contracted and approximate methods, and rough checks on numerical calculation; the meaning and use of logarithms, including the construction and use of the slide rule; calculation of numerical value from algebraic formulas; extraction of square roots; simplification of fractions; calculation of percentage, interest, discount, etc.

In algebra, the translation of verbal statements into algebraic language; numerical application of formulas; rule of in-

dices; factoring, and practise in general algebraic manipulation.

In mensuration, experimental testing of the rules for lengths of curves, for example, in the case of a circle, by rolling a disk, or by wrapping a string around a cylinder; verification of propositions in Euclid relating to areas by the use of squared paper, by means of a planimeter, by using Simpson's or other approximate rules, or by cutting the area out of cardboard and comparing its weight with that of a piece of known area;[6] rules for volumes of solids verified by their displacement of a liquid.

The experimental work in this subject ought to be taken up in connection with practise in weighing and measuring generally, finding specific gravities, illustrating the principle of Archimedes, determining the displacement of floating bodies, and other elementary scientific work. Good judgment will indicate the relative amount of experimental, didactic and numerical work.

The use of squared paper is especially emphasized. Some of its applications which are mentioned, are the plotting of statistics of general or special interest; study of the curves or lines so obtained, such as the determination of their maximum and minimum points, their rates of increase or decrease, etc.; interpolation, or the finding of intermediate values; probable errors of observation and the correction of same; determination of areas and volumes, as mentioned above; plotting of functions and the graphical solution of equations; determination of the laws between observed quantities.

In geometry, the experimental illustration of important propositions in Euclid, frequently supplemented by demonstration; measurement of angles by means of a protractor; definitions of trigonometric functions and the use of trigonometric tables; solution of right-angled triangles graphically and by calculation; construction of triangles and the experimental determination of their areas; method of locating a point in a plane and in space; the elements of descriptive geometry and vector analysis.

The advanced course proposed consists chiefly in an extension and elaboration of the elementary course. It includes demonstrative geometry, and rules in arithmetic and mensuration stated as algebraic formulas. In trigonometry, the study of special limits such as $\sin x/x$ and the derivation of the fundamental formulas and relations of trigonometry. In mensuration, the method of determining the constants in such physical formulas as $pv^m = c$. The course then proceeds to differential and integral calculus and their practical applications; differential equations illustrated by practical problems from mechanics and physics, descriptive geometry and vector analysis.

The reforms proposed by Professor Perry were widely discussed, and were, in general, favorably received. It was not to be expected, however, that the traditional teaching of Euclid in Great Britain would undergo any immediate or radical change, or, in fact, that any innovation of the kind proposed meet at the outset with a cordial reception.

In America, however, Professor Perry's views found ready acceptance and were carried more or less completely into effect. The result was what is now called the laboratory method of instruction which has been developed independently at several places, although along most radical lines at the University High School, Chicago. An outline of the laboratory system, together with a number of typical opinions

[6] This is the way in which Galileo is said to have determined the area of the cycloid.

as to its value and practicability, are given in what follows.

THE LABORATORY METHOD

The works of Klein and Perry mark the beginning of a movement to improve on present methods and make a more direct and pleasant path for the average student in the field of mathematics. The essence of the laboratory method consists in the performing of the bulk, if not all, of the work in the mathematical class room, which should be equipped with laboratory appliances for the graphic, the experimental and the concrete phases of the work. The teacher acts as the director of the laboratory, the pupils work individually or in small groups, and analogies with the work in the physical laboratory are emphasized.

The word *laboratory* undoubtedly came to be used largely from the suggestions received from analogous work in the physics laboratory. In 1886 Safford in his "Mathematical Teaching" said that a mathematical laboratory, although not often mentioned, was a necessity, and should contain such things as relate to ordinary, not purely scientific, measures.[7] Young calls attention to the fact that in the physics laboratory students work singly or in small groups under the general supervision of the instructor, but with direct contact with him for only a few minutes, and that this is a *limitation* of the physical laboratory, and not an advantage.[8]

The advantage of the class recitation over individual or private instruction has been pointed out by W. T. Harris, U. S. Commissioner of Education.[9] The class is the most potent of all instruments in the teacher's hand. He so manages the recitation or class exercise that each pupil learns to see the lesson through the minds of all his fellows, and likewise learns to criticize the imperfect statements made by them through the more adequate comprehension of the teacher. But because in mathematics the instruments are so simple, the benefit of laboratory work may be obtained under *class* direction, thus getting the good features of the laboratory system while avoiding its defects.

The procedure which physicists find best pedagogically suggests a plan for mathematics; namely, not that the mathematical class exercise be supplanted by a mathematical laboratory exercise, but that it be supplemented thereby. The mathematical class exercise should be conducted by some good method as at present, with the usual time allotment. This should then be supplemented by work in a well-equipped mathematical laboratory, either under the direction of the teacher or one or more assistants or both. The pupils should do substantially the same work in the laboratory, and the class exercise should prepare directly for it.

The feeling that mathematics must be made more concrete and must come into closer touch with the realities about the pupil, is growing in Germany, France, England and America; and the influence of the work of Perry can be distinctly marked in the current thought on the European continent.[10]

Professor Moore has defined pure mathematics as a language for the convenient expression and investigation of the most diverse relations of life and nature. The principles of the language are not arbitrary, but are imposed by the phenomena demanding expression.[11] From this it fol-

[7] "Mathematical Teaching," Safford, 1886, Heath & Co., 1896.

[8] "The Teaching of Mathematics," J. W. A. Young, Longmans, 1907.

[9] W. T. Harris, 1897.

[10] "Teaching of Mathematics," Young.

[11] "Cross Section Paper as a Mathematical Instrument," Moore, *School Science and Mathematics*, June, 1906.

lows that mathematics should not be presented ready made. The individual should make his own as the race has done; but not as if the race had never done it. That which is distinctly utilitarian in the course must be thoroughly practical and in accord with modern usage.

This idea has been amplified by Professor W. E. Story, who has pointed out that the education of the individual differs from the life history of the race in that the pupil is made to pass through the essential stages of development without wasting his time on what the experience of former generations has shown to be unessential. In other words, education is selective history, and whatever mode of selection most thoroughly excludes the unessential is most economical, enables the pupil to master the largest amount of what is essential, and gives him most time to devote to exploration of new fields when he has explored the old; that is, leads most rapidly to independent thought, which is the true goal of education.[12]

In America the term *laboratory method* has been coined to name the teaching of elementary mathematics as it would be if remodeled in accordance with the aims and ideals of the Perry movement. The dominating thought is a fuller consideration of the child mind; a sacrifice of the logical to the psychological, or rather a recognition that no method of instruction is truly logical which is not psychological. The keynote is interest, viz., that mathematics must be presented to the child in the most interesting way.[13]

One of the most significant features of this movement is its insistent demand for a closer correlation of subjects; or, more specifically, that mathematics and physics be organized into one coherent whole and no distinction recognized between mathematics and its principal applications. This, as shown in what precedes, is also the trend of ideas in Germany. It is essential that the pupil should be familiar, by way of experiment, illustration, measurement and every other possible means, with the ideas to which he applies his logic; and, moreover, should be thoroughly *interested* in the subject studied.[14]

Following out this idea, the secondary schools should advance independently of the primary ones, and algebra, geometry and physics, including astronomy and mathematical and physical geography, be organized into a four years' course comparable in strength and closeness of structure with the four years' course in Latin. The physics should be practical, and selected by an engineer, and the teacher should be trained in mathematics, physics and engineering. To carry out such a reform calls for the development of a thoroughgoing laboratory system of instruction in mathematics and physics, its principal aim being to develop the spirit of research and an appreciation of scientific methods.

One of the most important suggestions of the English movement is that by emphasizing steadily the practical sides of mathematics, that is, arithmetical computations, mechanical drawing and graphical methods generally, in continuous relations with problems in physics, chemistry and engineering, it would be possible to give very young students a great body of the essential notions of trigonometry, analytic geometry and the calculus. It is especially important that teachers in the primary schools should make wiser use of the foundations laid by the kindergarten. Cross-section

[12] "Unification of Mathematics in the School Curriculum," W. E. Story, *School Review*, 1903, pp. 832–55.

[13] "Mathematics in Commercial Work," E. L. Thurston, *School Review*, 1903, pp. 585–92.

[14] "Discussion on the Teaching of Mathematics," Perry, Macmillan, 1902.

paper, tables and blackboards should be used all through the grades. Drawing and paper folding should lead to intuitional geometry and mechanical drawing, and geometry be closely connected with numerical and literal arithmetic.[15]

As phenomena are observed by the individual, they should be described graphically and also in terms of number and measure. The graphical depiction serves to illuminate the quantitative determination, and *vice versa*.

The following has been suggested as a fairly complete equipment for a mathematical laboratory:[16]

1. Set of drawing instruments, board, T square, triangles (for each pupil).
2. India inks, paper, note-books, cross-section paper.
3. A large, well-lighted room, good drawing desks.
4. Carpenter's tapes, surveyor's tapes, architect's scales.
5. Three-, five-, seven-place logarithmic tables; pupils to choose which to use from accuracy of data.
6. Logarithmic slide rules and computing machine.
7. Surveyor's compass, transit, level, rod, poles.
8. Surveyor's plane table and sextant.
9. Steelyards, balances, pendulums, barometers, thermometers.
10. Force appliances such as pulleys and simple machines.
11. One hundred good texts on arithmetic, algebra, geometry, trigonometry, physics, elementary mechanics and astronomy, including Crelle's multiplication table.
12. A dozen treatises on these subjects, and a few good histories of mathematics and the mathematical sciences.
13. Spherical blackboards, concave and convex.
14. Three plane blackboards for projective and descriptive work in geometry.
15. Mathematical models.
16. Samples of actual engineering and architectural drawings of machines and structures.
17. Gyroscopic tops.
18. A set of Hanstein's models for projective work.
19. Stereopticon and slides.

The laboratory method has been given a thorough trial at the University School, Chicago, and methods have been developed and text-books prepared from the laboratory point of view. The aim or ideal of the work for the first year has been formulated by Professor Myers as follows:[17] (1) to generalize and extend arithmetical notions; (2) to follow up the notions of mensuration into their geometrical consequences; (3) to reconnoiter a broadly interesting and useful field of algebra; (4) to treat, with sufficient completeness for high schools, a large part of what is most practical and useful in elementary algebra. This means postponing the scientific and purely logical aspects of algebra to a later period.

Problems are drawn from arithmetic, mensuration, geometry, physics and elementary mechanics; and the equation is made the starting point and agency for developing the topics considered. The text-book which represents this first year's work is essentially an extensive and varied body of mathematical ideas correlated around an algebraic core.[18] The treatment begins with the informal methods of inductive arithmetic, passes to the uses of the equation and its transformations, and by degrees assumes a deductive character. Practical problems of a constructional or mensurational character have been found to appeal to first-year pupils with greater drawing force than any other problems of the text.

[15] "On the Foundations of Mathematics," Moore, *School Review*, 1903, pp. 521–38.

[16] "The Laboratory Method," C. W. Myers, *School Review*, 1903, pp. 727–41.

[17] "Year's Progress in the Mathematical Work of the University High School," G. W. Myers, *School Review*, 1907, pp. 576–93.

[18] "First-year Mathematics for Secondary Schools," G. W. Myers and others, University of Chicago Press.

In second-year mathematics geometry holds the center of attention, and arithmetical and algebraic elements are subordinated to it. The distinctive feature of the plan of presenting deductive geometrical truths consists of five general steps. The figure required by the demonstration is first sketched in the rough, in a way to exhibit clearly the conditions under which the truth in question is to be established. A careful drawing is next made on paper or on the blackboard with ruler and compass, under the specified conditions, and the appropriate parts of the figure that are drawn (protractor admitted) are carefully measured. Pupils are then required to make the best possible inferences as to the conclusions which follow from conforming to the imposed conditions. A correct enunciation of the principles to be established is next made and finally a deductive proof is given in standard form.

The mode of conducting the class work is a combination of the laboratory, the experimental, the Socratic and the class recitation modes. One of the advantages of the method is that it impresses the novice with the inadequacy of pure metrical means, and with the necessity of demonstrative methods.

As the result of six years' experience in teaching elementary high-school mathematics, Professor Lennes asserts his belief that graphical work is of great importance in creating interest and promoting a clearer and more satisfactory insight into subjects which too often are mysterious riddles.[19]

Professor Myers supplements this by saying that laboratory work with real problems, in the formulation and handling of which the pupil habituates himself to the transition from the concrete to the abstract, goes far toward supplementing the present isolated and abstract teaching of secondary mathematics.[20]

[19] "The Graph in High School Mathematics," N. J. Lennes, *School Review*, 1906.

THE PHILOSOPHIC ATTITUDE

The reforms proposed by Professor Perry emphasized the practical features of instruction. In geometry especially there was a radical departure from Euclidean methods in the direction of the utilitarian. This tendency, however, is not universal. Objection is raised by a certain school of pure mathematicians to any system of mathematical instruction which is not severely logical, and which considers the subject as a means rather than an end. The following views of Professor Halsted may be considered as typical of this demand that mathematics be taught from the outset as a formal training in rigorous thinking.[21]

Halsted asserts that there must be a course in rational geometry which is really rigorous. This course should be founded on a preliminary course which does not strive to be necessarily demonstrative, but should emphasize the constructive phase. The purpose of the preliminary course should be, as Hailmann has said, to develop clear, geometrical notions, to give skill in accurate construction, to cultivate a healthy, esthetic feeling, and the power of visualizing creatively in geometrical design, thus stimulating genuine, vital interest in the study of geometry.

This preliminary course must fit the rigorous treatise on rational geometry which Halsted says should be written by some one familiar with the new, penetrating, critical researches in the principles of geometry.

Instead of agreeing with Professor Perry that many of the theorems in Euclid might well be assumed as axiomatic, Halsted as-

[20] "Laboratory Equipment," Myers, *School Review*, 1903, pp. 727–41.

[21] Halsted, *Educational Review*, Vol. 24.

serts that greater rigor should be introduced, quoting Hilbert as saying that it is an error to believe that rigor in the proof is the enemy of simplicity.

With the new powers of insight given by the non-Euclidean geometry, and the introduction of Lobachevski's new principle in geometry, it was found that even Euclid made implicit assumptions. Thus, to make an angle congruent to a given angle involves a continuity assumption, while to prove other propositions requires a new set of assumptions which Halsted calls "betweenness assumptions," viz., of any three points of a straight line, there is always one, and only one, which lies between the other two.

The Euclidean method of superposition is also characterized as a worthless device; for if triangles are spatial but not material, there is a logical contradiction in the notion of moving them, while if they are material, they can not be perfectly rigid, and when superposed they are certain to be slightly deformed from the shape they had before.

Furthermore, so-called hypothetical constructions found in most text-books are criticized as illogical. Thus, certain propositions may require the construction of a regular heptagon or the trisection of an angle, although such constructions are impossible by elementary geometry. Thus, in many constructions, existential propositions are assumed. Helmholtz says of this: "In drawing any subsidiary line for the purpose of demonstration, the well-trained geometer asks always if it is possible to draw such a line."

This leads to the importance of not placing too great reliance upon diagrams. Bertram Russell says of Euclid I., that the first proposition assumes that the circles used in the construction intersect, an assumption not noticed by Euclid because of the dangerous habit of using figures. Hilbert believes in making frequent use of figures, but never depending upon them. The operations undertaken on a figure must always retain a purely logical validity. Halsted says that the beginners' course should consist largely in becoming familiar with figures, while in rational geometry that treatment of a proposition is best which connects it most closely with a visualization of the figures.

In rigorously founding a science, he believes that we should begin by setting up a system of assumptions containing an exact and complete description of the relations between the elementary concepts of this science. These axioms are at the same time the definitions of these elementary concepts. No statement within the science should be admitted as exact unless it can be derived from these assumptions by a definite number of logical deductions.

This criticism of the Perry movement and the laboratory method of instruction has recently been summarized by Professor Halsted as follows:[22]

> We knew that the so-called laboratory method for mathematics, the "measuring" method, was rotten at the core, since mathematics is not an experimental science, since no theorem of arithmetic, algebra or geometry can be proved by measurement; but, even granting the impossible, granting the super-human power of precise measurement, we could not thereby ever prove our space Euclidean, ever prove it the space taught in all our text-books.

THE PRACTICAL VIEW OF MATHEMATICS AS THE EXTENSION OF EXPERIENCE

One of the most sane and sensible views of the teaching of elementary mathematics yet presented is due to Professor Simon Newcomb.[23]

After recognizing the great difficulties

[22] "Even Perfect Measuring Impotent," Halsted, SCIENCE, October 25, 1907.

[23] Newcomb, *Educational Review*, Vol. 4.

inherent in the subject, Professor Newcomb goes on to say that in the teaching of elementary mathematics, especially arithmetic, care should be taken to embody mathematical ideas in a concrete form. The difficulty with the beginner is that he has no clear conception of the real significance of the subject which he is working upon. Figures and algebraic symbols do not represent to his mind anything which he can see or feel. So long as this continues his work consists of formal processes which have no correspondence in the world of sense.

Although a single experience may suffice to establish certain conceptions, it does not follow that the mind can apply these concepts in reasoning. It is one thing to know what a thing is but quite a different matter to handle it. This suggests that the difficulty in the teaching of elementary mathematics may be somewhat obviated by showing the mathematical relations among sensible objects.

To illustrate, not much progress was made in the study of imaginaries in algebra until Gauss and Cauchy conceived the idea of representing the two elements which enter into an algebraic imaginary by the position of a point in a plane. The motion of the point embodied the idea of the variation of the quantity, and the study of the subject was reduced to the study of the motion of points; in other words, an abstraction was replaced by a concrete representation. The result of this simple representation was that an extensive branch of mathematics was created, which would have been impossible if the abstract variable of algebra had not been replaced by the moving point of geometry. If such concrete representation is essential for expert mathematicians, it is obvious that immature pupils should be offered the same advantage.

In arithmetic, it is suggested that graphic methods be used throughout by way of illustration and explanation, lines being drawn to represent the numerical magnitude of the quantities involved. *Actual measurements, however, should not be made, but magnitudes should be estimated by the eye.*

This statement is especially noteworthy, as the idea implied seems to reconcile the differences between the ultra-practical and the ultra-logical extremes. The great danger in the laboratory method is that it will develop manual dexterity at the expense of intellectual power, or, from the ethical standpoint, that it will sacrifice the ideal to the material. The one pedagogical principle universally recognized, and the one on which it is claimed that the laboratory method is based, is that instruction should proceed from the concrete to the abstract. However, with the extensive laboratory equipment suggested by the advocates of the laboratory method, there must be a tendency, through lack of time if for no other reason, to remain with the concrete without making any sensible advance toward the abstract. Professor Newcomb's suggestion regarding the graphical depiction of relations without measurement, visualizes the idea to be presented without waste of time or involving the question of accuracy of measurement. The latter obviates the essential objection to graphical methods raised by Professor Halsted and others, and thus goes far toward meeting all demands, both critical and practical. Its simplicity, and the fact that this method has been, and is, in constant use, is also in its favor, and must appeal to all teachers who are interested in the progress of their pupils rather than in the exploitation of novel ideas.

It is also suggested that for at least one half the sums given in arithmetic, there be substituted a course of calculation of sizes,

weights and values of familiar things, such as, finding the dimensions of the schoolroom, the number of square feet in the floor and walls, the number of cubic feet in the room, the weight of the air in the room, the weight of the walls of the whole building, the number of bricks, etc. These would be more interesting than the complicated problems given in some of the advanced arithmetics.

Professor Newcomb deplores the fact that students who have taken a college course in physics can not compute the quantity of water which would be evaporated by the heat generated by the combustion of a ton of coal; or the number of cubic feet of air which could be warmed in the same way. He says that there is no good reason why this kind of elementary physics should not form a part of arithmetic, except adherence to traditional customs characteristic of the district school, and the prejudices of the so-called practical men against everything scientific in education.

In the study of geometry, the pupil should begin with constructive problems solved graphically; in beginning algebra, the pupil should first thoroughly familiarize himself with the use of symbolic language. Algebra is a kind of language, and to be proficient in its use this language must be learned by practise like any other unusual or foreign language.

Newcomb concludes by saying that it may be true that by adopting these suggestions the pupil would not get through any one book more rapidly and would make no better show of his knowledge upon examination. The advantages to be gained would be fewer courses, through fewer details of arithmetical applications being necessary, and a greater facility in the applications of arithmetic, algebra and geometry to practical questions.

A somewhat similar plea for practical mathematics is made by Fitzga in his work on natural methods of instruction.[24] The author first emphasizes the fact that in practise the use of mathematics arises from some external cause and that only concrete comprehensible things create a demand for its use, such as the coins, measures and weights in common use. The fact that numbers can not be seen, and that they are only phases of observation (*Beobachtungsmomente*) makes it necessary to present to the child's mind such objects, from which he can through observation fix numbers. In this selection much is gained if objects are chosen which will awaken interest. The things that interest the child most are those that are used in life, and such things as the child sees handled by adults. In the beginning of arithmetical instruction, therefore, numbers should be derived from different parts of the body, such as the fingers, eyes, etc., and later from arithmetical magnitudes (*Rechnungsgrössen*). These things are at first to be used for the purposes of observation lessons, for in this manner number presentations will be grasped without difficulty.

There is no question but that an exact knowledge of the mathematical magnitudes of life is necessary for the child, but the present methods of presentation do not permit of the exact observation of them. The child can not, through such a process, grasp the idea of magnitude, nor the relation of measures and their parts, and without this knowledge there can be no understanding of the subject. The observation of arithmetical magnitudes does not depend upon the physical properties of the objects observed, but upon the relation which they bear to one another. There are in each observation lesson certain vital features to

[24] "Die naturliche Methode des Rechenunterrichtes der Volks und Burgerschule," E. Fitzga, Wien, 1898.

which the observation of the child should be directed, and with such practise, numeration and figuring will follow of necessity. The aim of arithmetic should be chiefly to emphasize those arithmetical magnitudes which relate to practical life, and these should be presented to the child as objects of observation.

In order to determine the subject matter, it is necessary to consider that positive phases of the subject considered relate to practical life and in how far through the consideration of the subject matter can the moral and the cultural side of the child be nurtured.

The present lesson plans expect too much of the observational and comprehensive powers of the child, and it is certainly not a loss to the child if in the first-year arithmetic is not taught. In emphasizing the fundamental idea that numeration and arithmetical operations are chiefly to be acquired through the observations of arithmetical magnitudes, Fitzga expressly states that he does not approve of the rigorous handling of the subject matter. This, he says, naturally *assists the child in acquiring thoughtless habits.*

The conception of a thing only becomes clear when it is the abstraction of many similar and clear presentations. For this reason a teacher should not develop principles during a lesson in arithmetic, but should discourage the use of principles even by the brighter pupils, who have grasped these principles during the process of development, for the weaker pupils will immediately use them, and will not trouble themselves to acquire them through a process of logical reasoning. The teacher who wishes to bring his pupils to a clear comprehension of arithmetical problems can not develop any principles, but must wait until the child shall see the principles himself in the progress of his work.

Instead of the rigorous treatment of the subject, and the development of principles, Fitzga has, therefore, divided the separate parts of the subject matter into elements from which follows a logical arrangement based on the idea of repeated observations and presentations necessary to form clear conceptions of the different arithmetical operations.[25]

He also points out that it is necessary to choose examples in such a way that the context of the problem is comprehensible to the child. For this purpose it is necessary to bring to the mind of the child the various relations of practical life, out of which the examples are taken, and this can be done by giving a system of logical observation lessons.

The method of giving observational lessons as the basis of mathematical instruction has been explained in considerable detail by Jackman.[26] The article referred to is primarily a plea for the correlation of mathematics and physics, on the ground that mathematics has become so isolated that it is universally considered as the bugbear of the curriculum. This, it is stated, is due to the fact that the problems deal with subject matter with which the pupil has no concern, and mathematics has thus become simply a science of empty processes.

The question of the hour in the teaching of mathematics is not how do pupils in their thinking develop ideas of exact quantitative results, but ideas of what quantitative results are worth developing.

The unfortunate position in which mathematics finds itself is also partly due to the mistaken idea that a constant manipulation of mathematical formulas has a peculiar disciplinary value, whether they give any decidedly useful results or not. Great

[25] For courses in detail see his book, mentioned above.

[26] Jackman, *Educational Review*, Vol. 25.

mathematicians, however, have always acquired their disciplined powers while in the pursuit of knowledge having intrinsic worth, which indicates that mathematics should be related to actually useful and related things.

The past decade has seen a revolution in the schools. The old-time school with its barrenness of resource has been abolished, and the pupil has been placed in direct contact with all the vital activities of his time. To-day the child thinks through his hands, and it is currently believed that mathematics can play only a limited part in the new education. Yet since the whole universe is a manifestation of energy, mathematics must find its place in every subject. As a matter of fact, it is closely identified with physics and has already found its place in biology, botany, zoology, etc.

A radical change in the usual methods of presenting the mathematical branches must be made. Instead of taking them tandem fashion, the subjects of arithmetic, geometry and algebra must go hand in hand. The child solves the question for himself by introducing them all at once even before he enters school. It becomes then simply a question of assisting the pupil in the further development of the mathematical powers which he began to employ spontaneously before he came to school at all.

To illustrate the preceding principles and methods an outline of some work done in the eighth grade of the University Elementary School (Chicago) is given. The subject was botany and the pupils were allowed to take their time to work out the problems, as their observations demanded. In doing the work, the following principles were observed:

1. There must be a clear, general notion of the image to be developed.

2. There must be a careful selection of appropriate units of measurement.

3. The most expeditious methods of measurement or of applying the units must be chosen. Estimate first; then measure.

4. There must be a careful selection of processes by which the comparisons are made.

5. This must be followed by an objective representation of the results in the form of data obtained by observation. Gallons, quarts, pints, feet, yards, square feet, square yards, acres, miles, etc., must be seen until they become a part of the mental equipment.

6. Using the results obtained as data, a great nature picture must be constructed. That is to say, through the original and primary conception under which the pupil has been working, the real magnitude of world operations should be made to appear in definite quantitative results.

To illustrate these principles, the dispersal of seed was chosen as subject matter. The observation material in this case was found in a vacant city lot adjoining the school, and by extending the calculations to allied subjects, such as the amount of solar radiation, and of annual rainfall, the fundamental operations of arithmetic were thoroughly covered. The details of the work are fully explained in the last-mentioned article.

S. E. Slocum
University of Cincinnati

William Eimbeck, 1841–1909[1]

Mr. William Eimbeck, the subject of this sketch, and myself were close friends for many years. His ambitions were well known to me, and I am very well aware that his failure to attain the final success he had hoped for was due to an organic disease which slowly crept upon him during the later years of his life.

[1] Memorial address before the Philosophical Society of Washington, May 22, 1909.

He was born January 29, 1841, in Brunswick, Germany, and beginning his education in the public schools and gymnasiums of his native city, he came to the United States at an early age and completed his training as civil engineer under private instruction in St. Louis. His first professional experience was in connection with the building of the Eads bridge at St. Louis, and in the offices of the St. Louis City and County Engineers. Later for two years he was professor of mechanics and civil engineering in Washington University.

In 1869 Professor J. E. Hilgard, the assistant in charge of the Coast Survey and later its superintendent, had organized a series of parties to observe the solar eclipse of August 7 of that year. Mr. Eimbeck was an enthusiastic volunteer observer and was assigned to the party of Julius Pitzman, county engineer of St. Louis, and stationed near Mitchell, Ill. After the eclipse he took part in the determination of the latitude and longitude of St. Louis, and the connection of the various eclipse stations in Missouri and Illinois with this base station. His enthusiasm and success in this work led to his selection as an observer in the expedition organized by Professor Benjamin Peirce, then superintendent of the Coast Survey, to go to southern Europe to observe the solar eclipse of December 22, 1870. Mr. Eimbeck was assigned to the party of Professor C. H. F. Peters, the distinguished astronomer, with whom he observed the eclipse on Monte Rosso near Catania in Sicily. His ability, acquirements and enthusiasm displayed on these two expeditions led to his appointment on the Coast Survey, July 1, 1871, and his connection with it continued for thirty-five years.

His first assignment was to one of the triangulation parties on the survey along the thirty-ninth parallel of latitude which was operating in Missouri, extending the work westward from the base in the Great American Bottom opposite St. Louis; and later he was engaged in astronomical duties in connection with determination of latitudes, longitudes and azimuths in Kansas, Texas and Louisiana.

In 1872 he was assigned to the Pacific coast and for five years was engaged in astronomical and primary triangulation work along that coast from Oregon to the entrance of the Gulf of California; one of his undertakings being a determination of the geographical coordinates and magnetic elements at thirteen stations between San Diego and Cape San Lucas for the control of the survey of the coast and Lower California then in process of execution by the Navy Department. In 1872 in the superintendent's report is an evidence of the thorough spirit in which he entered upon securing a thorough command of all the details of the scientific operations upon which he was engaged, this being shown by his paper suggesting improvements in the Hipp chronograph then used in connection with the telegraphic longitude operations.

In 1877 he returned to the eastern coast, where he was assigned to an extensive astronomical and magnetic campaign for determination of latitudes, longitudes and the magnetic elements in Kentucky, Illinois, Tennessee, South Carolina and Georgia, and later, after making the necessary preparations, in 1878 he was again assigned to the western coast and began at Pah Rah in Nevada the extension of the primary work eastward from the coast triangulation, which was to follow approximately the thirty-ninth parallel of latitude to the capes of Delaware. This was the inception of what was to be the main life work of Mr. Eimbeck and to which for eighteen years he gave all that was best in both mind and body. Stretching from the Sierra Nevadas to Pikes Peak and the east line of the Rocky Mountains, and including in its list of occupied stations mountain peaks reaching an elevation of 14,400 feet, in regions where supplies had to be carried for hundreds of miles through deserts and wastes, destitute of roads and almost destitute even of water; the successful conduct of this work called for the endurance of the most rugged of pioneers, the undaunted courage of the explorer, while the operations represent the highest type of

work demanded from the scientist and observer. In this triangulation one line, observed in both directions, is over 183 miles long and is not exceeded in the work of any country.

There are two instances where the change between adjoining stations necessitated a journey of 300 miles, one of these being the transfer of parties from Mount Ellen to Mt. Tavaputs, made under fierce suns of August and September, across a desert section which tested almost to their limits the endurance of the men and animals, and it is remarkable to relate that in his most expansive moments Eimbeck never seemed to consider that any special merit could be claimed for successfully overcoming all these hardships and dangers. A reference to the annual report of the superintendent will emphasize this feature of our friend's character, as therein will be found only a simple statement of the work completed each year, because of the modesty which would not permit him to give adequate account of the toils he faced and conquered.

Near the close of this great triangulation, Mr. Eimbeck designed the duplex base apparatus which was constructed at the Coast and Geodetic Survey Office and used by him in the measurement of the Salt Lake base.

In addition to the field work upon which he was so actively engaged, he was always deeply interested in every branch of the work of the survey, and specially those pertaining to geodesy. In 1900 he undertook an elaborate series of experiments for the study of the seasonal range in the value of the coefficient of refraction, but a final report was never received from him; although he made several announcements of the satisfactory progress he was making in the perfection of a theory for this important term. His study of the question of the existence of sensible tides in the earth's surface had also occupied his attention for many years and was the object of study with him up to his last days. It is known that he gave profound study to the problems of the tides, gravity, the causes of the variations of latitudes, etc., and it is also known from his own statements that he was preparing his theories for publication. The most frequent references to Mr. Eimbeck by his intimate associates are appreciations of his suggestive and illuminating discussions of many of the problems that attract the physicist and astronomer, and all the problems to which the geodesist gives attention.

In appearance Mr. Eimbeck was the elegant and distinguished gentleman. Tall, erect, of fine proportions and handsome features, he was often admired as he walked the streets of Washington carrying an overcoat on his arm, which he disdained to wear even in the coldest weather. In his early days he was of robust health, but as early as 1890 he began to complain that he could no longer endure either the physical or mental strain of former years. A few years later he thought he had Bright's disease, but would not consult a physician. This disease, with the complications that so frequently come with it, slowly crept upon him, till in 1906 he resigned from the survey, hoping a life free from care would improve if not restore his health. It was too late—he gradually failed, and finally on March 27, 1909, his death resulted from a stroke of paralysis.

Mr. Eimbeck was a founder member of the Cosmos Club, for thirty years a fellow of the American Association for the Advancement of Science, a member of the Washington Academy of Sciences, of the National Geographic Society, of the Geological Society and of the Washington Philosophical Society.

In closing this sketch of the life of Mr. Eimbeck, I wish to quote from a little notice that was issued to the members of the Coast and Geodetic Survey a few weeks since:

> A lifetime of study and research added to charming natural eloquence and marked clarity in exposition made Mr. Eimbeck one of the most interesting and instructive companions, these distinguished qualifications being set off by a modesty as extraordinary as the merits it failed to obscure. Broad and tolerant in his sympathies and with no thought for self in his generosity to the unfortunate, the life just closed is one that can justly claim only praise when it is referred to, and affection when it is recalled.

Edwin Smith

THE PROTECTION OF NATURAL MONUMENTS

ABOUT a year ago I caused to be distributed broadcast in this state a circular inviting local public attention to the importance and desirability of protecting our natural memorials. Though behind this call there has been neither organized effort nor public funds, there is good evidence that in some instances the suggestions embodied in the circular have been seriously entertained and perhaps may have had some practical result. Such efforts, it would seem, must be essentially localized at the start and perhaps, to effect the best results, should remain so.

The conservation of especially interesting natural monuments comes somewhat late in the development of the sentiment of a community, with the increase in the appreciation of nature's works. There are lovers of birds who see with profound regret the disappearance of certain of their friends once common in the region, but gradually driven away by the encroachments of commerce upon their nesting places. There are lovers of plants who know the few remaining spots where rare flowers bloom or rare ferns may be found. What comparison does a loyal citizen make between a noble tree which has seen the centuries roll by, which has stood sentinel over the community since the cradle days of the settlement, and the light or telephone company which lops off one of its branches to let a wire go through or thrusts an ugly pole into its boughs? A wooden telephone pole with its cross-trees is to-day in our cities and villages the cross on which every sentiment of good and decent taste is crucified. There are persons in almost every community who can be better spared than some of its venerable trees. It is not only the age of a tree that entitles it to guardianship; there are some which have especial associations with distinguished personages of the past, others may be the last survivors of a race which once abounded but whose companions have disappeared under the woodsman's axe. A great glacial rock boulder projecting alone from some meadow or hillside, tells a romantic age-long story which should not be menaced by the workman's sledge. There are bits of swamp still profuse in rare orchids, and clumps of woodland where rare birds still nest but which will soon be robbed of their possessions if measures are not taken for their protection.

No part of any of our states is without such objects which appeal to the thoughtful citizen for protection—the lesser objects which could not be well brought within the supervision of societies of national scope, like our American Scenic and Historic Preservation Society, or even of recognized state organizations. In my circular I undertook to indicate some of these minor objects which had come to my notice within this state as entitled to protection either for their intrinsic character or their historic associations, such as the rock bridge over the Perch River; a burless chestnut near the village of Freehold, unique in the state; an arbor vitæ of enormous size on Lake Colden; the extinct volcano near Schuylerville, which served as "Stark's redoubt" in the campaign of 1777, and so on. It would be no difficult matter to complete a census of such objects which might serve as a guide to local interest and contribute much to the general attractiveness of any community. Our American culture does not run easily to sentiment and opportunities for conserving such natural memorials lightly pass, only to be followed by regret for their loss; for the opportunity once gone, it is forever too late; the damage once done can never be repaired. And it is worth while saving these things, for lovers of nature and the out-of-doors, students of science and of history, intelligent members of every community in this and in the generations after us, will approve the doing.

In such a movement we have to take our lesson and inspiration from the older and higher culture of Germany, where substantial progress has been made in protecting such objects of natural interest. There the methods employed and the results achieved are interesting. An old fir tree gnarled with years in the forests of Lueneburg is set apart and protected for its very age and fascinating ugliness. A little patch of dwarf birch, a

rare survivor of the postglacial flora, is preserved and protected in the vicinity of Hamburg. A considerable area of forest near Münster is protected because of its profusion in certain rare species of lichens. In Schleswig a great glacial boulder resting on a low knoll has been set aside, the ground immediately about it acquired and a road laid out to it. In Brandenburg a little lake with its swamp, the Plage, has been reserved on account of its botanic interest and in Marienwerder a bit of lake and woods where rare water birds nest. A local society in Gotha has acquired a small pond and swamp and has transferred to it rare plants threatened with extinction and has also introduced new plants foreign to the region, such as our common *Sarracenia* or Pitcher-plant. Such results as these have been attained largely through the activity of local societies and are the outcome of local pride and intelligent appreciation, but Prussia has an official duly appointed by the Cultus Minister as State Commissioner for the Care of Natural Monuments, Dr. H. Conwentz, director of the Provincial Museum at Danzig, and through his activity aided by the official forestry organization, much has been possible which would be more difficult here without such aid. The methods employed by Dr. Conwentz have enlisted a more than local interest and the Cambridge Press has recently published his address on his work delivered by request before the British Association last year.

It is not likely that any American state will very soon accord recognition to this movement by following the example of Prussia in designating an official as its apostle to arouse local loyalty and supervise such conservation but the whole matter, it would seem, might with entire propriety be embraced within the scope of the national conservation movement whose official support could be so enlisted and so delegated as to efficiently enforce the subject on public and local attention and even on private munificence. I am not aware that the functions of the National Conservation Commission are so restricted as to restrain it from taking cognizance of this growing favorable sentiment toward such conservation as I have indicated and if such authority may properly be assumed by it, it would be no difficult matter to find some active spirit in each state to whom the moral and official support of the commission might be given in the furtherance of so laudable an undertaking.

John M. Clarke,
Director, Science Division
Albany, N. Y.,
June 16, 1909

THE DARWIN CENTENARY AT CAMBRIDGE[1]

The Darwin celebration, which began on June 22, is a remarkable event in university annals. Commemorative festivals, held at one or other ancient seat of learning, have been frequent in recent years; but their object has been to celebrate the foundation of some famous institution in the distant past. And there have been festivals of a different kind in honor of one or other of the great names on the roll of intellectual achievement, whose glory has been established and consecrated by the long lapse of time. But no such academic tribute as the present festival has ever been paid to the memory of an individual within so short a time of his own life.

The great and ancient University of Cambridge is devoting three days to it, and the whole learned world from Chile to Japan is joining in homage to the memory of an Englishman who was with us but the other day. Some of those who will be present were his comrades, most of them have been in some measure his working contemporaries. Two hundred and thirty-five universities, academies and learned bodies at home and abroad have nominated delegates to represent them: and of these 167 are situated in foreign countries and British dominions outside the United Kingdom. Thirty of the most famous institutions in Germany, thirty in the United States, fourteen in France, ten in Austria-Hungary, eight in Italy, as many in Sweden, seven in Russia and lesser numbers in seven other foreign countries have honored the occasion by naming some of their most distin-

[1] From the London *Times*.

guished members to take part in it. The distant seats of learning in the younger British countries have responded with not less cordiality; seven in Canada, seven in Australia, five in New Zealand and the same number in South Africa have appointed delegates; India and Ceylon are represented by eight. Within the United Kingdom 68 universities and societies are lending their support; and, in addition to the appointed delegates, there are some 200 invited guests, who include men eminent in every walk of life.

A share in evoking this extraordinary manifestation of world-wide respect belongs, of course, to the prestige of Cambridge University, which is acting as host; but Cambridge could not have planned a festival on this scale or sent out the invitations in honor of a lesser man. Other great men were born in the famous year 1809, and one at least was at Cambridge; but it is impossible to conceive a pious pilgrimage of this sort to celebrate their birth. It helps us to realize the immense space on the intellectual horizon of the world filled by the figure of the great observer and generalizer. His achievement has, in a sense, become so familiar, its indirect influence has so closely interpenetrated the general consciousness of mankind that we can hardly see it plain or measure its proportions. It is not a matter for the learned only, but for all of us. To no other man has it been given to effect a revolution in human thought so large, so pervading, so sudden, and yet so enduring. Darwin taught mankind to see all things in a new light, not only the operations of nature, great and small, the mysteries of existence and the innumerable objects of research, but the common things of every-day life.

SCIENTIFIC NOTES AND NEWS

YALE UNIVERSITY has given its doctorate of science to Dr. E. W. Morley, emeritus professor of chemistry at Western Reserve University; to Dr. Wm. T. Sedgwick, professor of biology at the Massachusetts Institute of Technology, a graduate of the Sheffield Scientific School, and to Dr. E. H. Moore, professor of mathematics of the University of Chicago, a graduate in arts and philosophy at Yale University.

DR. S. F. EMMONS, of the U. S. Geological Survey, has received the doctorate of science from Harvard University.

WASHINGTON AND JEFFERSON COLLEGE has conferred the degree of doctor of science on Dr. C. H. Townsend, of the New York Aquarium.

THE delegates to the Darwin commemoration on whom the degree of doctor of science was conferred by the University of Cambridge are: Édouard van Beneden, professor of zoology at Liége; Prince Roland Bonaparte, Paris; Geheimrat Bütschli, professor of zoology and paleontology at Heidelberg; Robert Chodat, professor of botany at Geneva; Francis Darwin, F.R.S., honorary fellow of Christ's College, and formerly reader in botany; Karl F. Goebel, professor of botany at Munich; Ludwig von Graff, professor of zoology and comparative anatomy at the University of Graz and president-elect of the International Zoological Congress which meets at Graz next year; Richard Hertwig, professor of zoology and comparative anatomy at Munich; Harold Höffding, professor of philosophy at Copenhagen; Jacques Loeb, professor of physiology in the University of California; Edmond Perrier, director of the Natural History Museum of Paris; Gustav Albert Schwalbe, professor of anatomy at Strassburg; Hermann Graf zu Solms-Laubach, professor of botany at Strassburg; Clement Timiriazeff, professor of botany in Moscow; Frantisek Vejdovsky, professor of zoology in the Bohemian University of Prague; Max Verworn, professor of physiology at Göttingen; Hermann Vöchting, professor of botany at Tübingen; Hugo de Vries, professor of botany at Amsterdam; Charles D. Walcott, secretary of the Smithsonian Institution at Washington; E. B. Wilson, professor of zoology in Columbia University, New York; and Charles René Zeiller, professor of paleobotany in the École des Mines, Paris.

AT the commencement of Harvard University on June 30 the degrees of doctor of laws

and doctor of medicine were conferred on Dr. Charles W. Eliot, who has been made by the corporation president emeritus of the university. In conferring these degrees President Lowell said: "Charles William Eliot, teacher, administrator, orator, prophet; forty years the leader and the guide of Harvard, and in the single-minded elevation of his character a model to her sons; the father of the present American university, the brother of all teachers and the friend of every lover of his country: It has not been our custom to confer the degree of doctor of medicine, *honoris causa;* but an exception is fitting in the case of one who, in the opinion of professors of medicine, has accomplished more for the progress of medical education in this country than any other living man, Charles William Eliot. Not in its buildings alone, but also in the instruction and research within its walls, he found our medical school brick and left it marble."

The Royal Society of Arts has awarded its Albert medal to Sir Andrew Noble, K.C.B., F.R.S., "in recognition of his long-continued and valuable researches into the nature and action of explosives, which have resulted in the great development and improvement of modern ordnance."

M. J. Vallot has been elected by the Société des Observatoires du Mont Blanc director of the observatory founded by the late M. Janssen. He is now director of two observatories on Mont Blanc.

Mr. A. F. Crider has resigned the directorship of the State Geological Survey of Mississippi and Dr. E. H. Lowe, formerly professor of geology in the University of Mississippi, has been elected to the position.

Dr. John H. Musser, professor of clinical medicine at the University of Pennsylvania, is chairman of the American delegation to the International Medical Congress, which will be held this year in Budapest.

Under the direction of Professor Charles Lane Poor, of Columbia University, an expedition has been fitted out to measure the tidal currents of Point Judith and Block Island. Professor Poor will supervise the work from his yacht "Weetamoe"—the station boat being the auxiliary power boat "Gracie." The observations will be made by Messrs. Brainin and Ladd.

Edwin F. Stimpson, assistant professor of physics, University of Kansas, has obtained leave of absence for one year to accept a position as inspector of weights and measures in the Bureau of Standards. At the last session of Congress, an appropriation of ten thousand dollars was made for an investigation in regard to the efficiency of the inspection service in the different states, to ascertain to what extent fraud is practised in interstate commerce. The bureau proposes to send inspectors to the different states to advise with the local authorities and to assist them in procuring the proper equipment and in adopting uniform regulations. The appropriation is only for one year and every effort will be made to cover the country, and to be in position to render a final report to congress by next June.

Mr. J. W. Jenkinson, demonstrator at the Natural History Museum, Oxford, has been elected a fellow of Exeter College.

Professor Charles L. Edwards, of Trinity College, expects to spend the next fifteen months in Europe. During the present summer he will work in one or more of the Scandinavian marine biological stations, from October to March with Professor Boveri at Würzburg and then in the spring at Naples. In the summer of 1910 he expects to attend the Eighth International Zoological Congress at Gratz.

The Danish government has sent an expedition under Captain Elmar Mikkelsen to Greenland to search for the bodies of Mylius Erichsen and the other explorers who perished in November, 1907.

It is said that Professor Hergesell will have charge of a dirigible airship under the general direction of Count Zeppelin, which will next year undertake explorations in the polar regions and if it proves feasible will undertake to reach the North Pole.

DURING the recent commencement week of the Ohio State University two memorials were presented by the alumni. An oil portrait of James Hulme Canfield, fourth president of Ohio State University and later librarian of Columbia University. This was painted by Mr. George Bellows, of New York City, an Ohio state man. The second memorial was a large bronze tablet for Townshend Hall, one of the agricultural buildings of the university. This tablet contains a life-size medallion portrait of Dr. Townshend and the following inscription:

TO THE MEMORY OF
NORTON STRANGE TOWNSHEND
1815–1895
BELOVED PHYSICIAN, FRIEND OF THE
CAUSE OF HUMAN FREEDOM, WISE LAWMAKER,
A PIONEER IN AGRICULTURAL EDUCATION,
ONE OF THE FOUNDERS OF THIS UNIVERSITY
AND ITS FIRST PROFESSOR OF AGRICULTURE
THE STUDENTS OF AGRICULTURE
AND OF VETERINARY MEDICINE
HAVE PLACED THIS TABLET
A.D. 1909

WE regret to announce the death, June 20, at Copenhagen, Denmark, of the distinguished naturalist and physician, Dr. Rudolph Bergh, well known among zoologists for his work on the nudibranchiate mollusks.

THE U. S. Civil Service Commission announces an examination on July 14, to fill a vacancy in the position of editor, in the bureau of education, Department of the Interior, at a salary of $2,000 per annum. The duties of the position will be performed chiefly at Washington, and will include correspondence, report writing, editing and the preparation of original articles concerning the various phases of education. There will also be occasional work outside of Washington studying educational institutions and problems, attending conferences, and giving addresses at important public meetings. It is desired to secure in the appointee selected one having a broad general education who has also specialized in the study of education and has a wide knowledge of educational literature, including current publications, so that he will be able to give advice and to furnish information concerning matters which may be of interest to the educational public at any given time. It is not essential that he should be skilled in the preparation of copy or in the reading of proof. Men only will be admitted to this examination.

HARVARD UNIVERSITY has received an anonymous gift of $5,000 to establish a fund, the annual income of which is to be used for the support of a summer field course in structural or stratigraphical geology, conducted preferably in the mountain region of western North America, for the benefit of students who have an elementary knowledge of the subject.

MR. F. G. SMART has given the University of Cambridge £600 to establish two prizes to be awarded each year in botany and in zoology.

A RESEARCH studentship in actinotherapeutics, of the annual value of £300, to be known as the Douglas research studentship, has been established at Guy's hospital, London.

MR. FRANK SPRINGER has presented to the museum of the University of Colorado a collection of more than fifty species of fossil Crinoids and Blastoids.

THE Rhode Island legislature at the last session appropriated $2,500 annually for three years for a survey of the natural resources of the state. The work was placed under the general charge of the Bureau of Industrial Statistics, Colonel George H. Webb, commissioner, who has appointed Professor Charles W. Brown, head of the department of geology at Brown University, to take immediate direction of the survey. Mr. Nelson C. Dale, A.M., and I. R. Sheldon, '10, have been appointed field assistants.

THE Illinois State Laboratory of Natural History has recommenced biological work on the Illinois River and dependent waters at Havana (Illinois), in continuation of the work interrupted in 1899. The plan of operations involves an ecological and economic study of the entire river system, to include both the plant and animal contents of the waters, and their relations to the environment in general and detail. The work is in charge of Dr. S. A. Forbes, director of the laboratory, with Mr. R. E. Richardson as resident assis-

tant at Havana. A committee on an ecological survey appointed by the Illinois Academy of Science, of which Dr. Forbes is chairman, is associated with this work in an advisory capacity, and the members of the committee will share in its investigations. The station is equipped with a floating laboratory, a gasoline launch and the various apparatus necessary for aquatic collection and investigation. It is the intention of the management to open the station to biological and ecological investigators during the summer of 1910.

The third meeting of the permanent commission of the International Seismological Association will take place August 30 to September 4, at Zermatt, Switzerland.

Through the kindness of Professor Lambrecht and Dr. Davies, of the University of Leipzig, arrangements have been made for a special room for Americans who visit the celebration at the 500th anniversary of the founding of Leipzig University. This room is at the Goldner Bär, Universität Strasse 11. Americans should register at this place and they will here be given any information that they need for the celebration.

UNIVERSITY AND EDUCATIONAL NEWS

Among gifts to Yale University announced at the recent commencement were $100,000 to establish a John Sloane memorial fund for the increase of salaries and two gifts of $20,000 each towards the establishment of a professorship of education. It is further announced that a compromise has been effected in the case of the will of Frederick C. Hewitt, by which the university will receive $400,000.

The Drapers' Company have renewed their grant of £2,000 (£400 a year for five years) to the department of applied mathematics in London University under Professor Karl Pearson, thus enabling the research work in statistics and in the biometric laboratory to be continued and extended. The Mercers' Company have made a grant of £500 to the department of physiology.

The new Institute of Physiology at University College, London, was opened on June 17 by Mr. Haldane, the secretary of state for war.

Dr. Henry B. Ward, of the University of Nebraska, has accepted a professorship of zoology in the University of Illinois.

Dr. Raymond H. Stetson, of Beloit College, has been appointed professor of psychology at Oberlin College.

Dr. Frank N. Freeman, who for the past year has held the traveling fellowship in philosophy and psychology from Yale University, has been appointed instructor in educational psychology in the University of Chicago.

Mr. Clinton R. Stauffer, A.M. (Ohio State) has been appointed instructor in geology in Western Reserve University.

Professor Charles E. Decker, now in the graduate school of the University of Chicago, has been appointed instructor in biology and geology at Allegheny College for the coming year.

Appointments and promotions in the St. Louis University School of Medicine are announced as follows: Dr. M. F. Engman has been made professor of dermatology in place of Dr. John H. Duncan, resigned. Drs. J. W. Marchildon, J. J. Honwink and R. D. Carman have been advanced from instructors to assistant professors of bacteriology, dermatology and "roentgenology," respectively.

DISCUSSION AND CORRESPONDENCE

"THE DAYLIGHT SAVING BILL"

To the Editor of Science: The reference to the bill in Science for June 18, 1909, page 973, in the interesting letter of "T. C. M." is not quite accurate. The bill was introduced in the Indiana legislature and provided that the ratio of the circumference to the diameter of the circle should be exactly three to one. It was referred to "The Committee on Swamp Lands." The introducer of the bill evidently had never heard of π, and if he had, would probably have considered it a symbol of traditional New England breakfast dish.

The published report of the hearings before the special committee of parliament on the "Daylight Saving Bill," from which the

following quotations are taken, does not indicate that it is supported by many distinguished men of science. It was testified that the "Science Guild" of which Sir Norman Lockyer is chairman, and which is composed of "scientific people or people who take an interest in science" feels "that it is a great mistake to tamper with time." The bill was strongly opposed by Sir William H. M. Christie, the astronomer royal, and Sir David Gill, who was recently his majesty's astronomer at the Cape of Good Hope. It was through the influence and active work of the latter that standard time was substituted for local time in South Africa in 1903. The bill was favored by Professor Rambaut, professor of astronomy in the University of Dublin, and Sir Robert S. Ball, formerly astronomer royal of Ireland, but both of these gentlemen strongly opposed the proposition to set the clocks one hour ahead. They favored the idea of making three changes of twenty minutes for the summer, returning to Greenwich mean time for the winter; in other words, the long-hour and short-hour plan. To this the practical objections are very great and it is understood that its advocacy before parliament has now been definitely abandoned.

Sir William H. M. Christie called attention to the fact that neither Sir Robert Ball nor Professor Rambaut, when in Ireland, had "succeeded in persuading their countrymen of the advantages of early rising which might have been secured by substituting Greenwich for Dublin time, the Irish clocks being thus put twenty-five minutes forward," although they tried to do so.

The tenor of all the arguments in favor of the bill was that many persons would be deceived into getting up earlier by setting the clocks ahead when they could not be persuaded to do so otherwise.

It is reported in the daily papers that many English employers have voluntarily arranged to have the day's work of their employes commence a half hour or an hour earlier in the summer, thus securing honestly the advantage it is claimed people would gain by changing the clocks and without "juggling with the uniform measurement of time" as Sir William Christie properly terms it.

When the mass of the English people come to fully realize that by shifting the clocks an hour ahead they will be adopting a time *made in Germany,* perhaps their patriotic impulses will induce them to come to the assistance of common-sense people and make any attempt to pass the so-called "Daylight Saving Bill" absolutely hopeless.

W. F. A.

NEW YORK CITY

A REMARKABLE AURORA BOREALIS

ONE of the brightest auroras seen in recent years at Blue Hill Observatory was visible for several hours on the evening of May 15 last. When first observed, at 8:58 P.M., it formed three detached luminous patches, the two brightest having been near the zenith. At 9:10 P.M. the latter two merged to form one large bluish-gray mass, of unusual brightness. After that, the luminosity changed rapidly from moment to moment, while the form was altered but slightly, the whole mass moving slowly to the south and west. For about three quarters of an hour the main mass took the shape of a long-handled dipper, the bowl appearing like the head, and the handle like the tail of a huge comet, which many people thought the phenomenon to be. At 10:36 P.M. it was seen as five detached areas of light, which, after about ten minutes, joined to form an unbroken arch which reached from west to east almost entirely across the sky, the highest point passing slightly to the south of the zenith. After 11 o'clock the arch broke up into separate masses which changed in brilliancy from time to time, but gradually faded until all had disappeared by 11:30 P.M. In the two hours from 8:59 P.M. to 10:59 P.M. the mass moved as a whole about 25° toward the south and about 50° toward the west, as measured from a point near the center of the main mass which was originally about 5° to the north of the zenith. After 10 o'clock we had the unusual condition of the "northern lights" entirely to the south of a west-to-east line through the zenith. It is also worthy of note that the southern border was at all times a

distinct and clean-cut line, while the northern border was everywhere indefinite, gradually dying out at about 30° to the north of the zenith. During the course of the evening the luminous area varied in width from 10° to about 35°.

The aurora was remarkable on account of its unusual position, its rapid changes in brilliancy, and its varying shape. The color was a pale bluish-gray, no iridescence having been seen at any time. Moreover, there was no suggestion of streamers or rapidly-moving iridescent patches, often referred to as "merry-dancers." When the aurora was at its maximum brilliancy, only the stars of brightest magnitude could be seen in that region of the sky, and the "milky way" was rendered entirely invisible. Over nine tenths of the sky was cloudless throughout the evening, a trace of alto-stratus cloud having been visible above the northern horizon, and an equal amount of cumulo-nimbus cloud with distant lightning having been seen far off to the west.

Andrew H. Palmer
Blue Hill Observatory,
May 17, 1909

SCIENTIFIC BOOKS

Elements of Optical Mineralogy, An Introduction to Microscopic Petrography. By N. H. Winchell and Alexander N. Winchell. New York, D. Van Nostrand Company. 1908. Pp. 502; 350 figures; 4 plates. Price, $3.50.

During the last few years several excellent treatises on optical mineralogy by Americans have appeared, namely, those by Luquer, Iddings and Johannsen. According to the authors, none of these contains a concise and clear exposition of the principles, methods and data of optical mineralogy. It is to supply this want that this text was written.

The book is divided into three parts, as follows: (1) Principles and Methods, (2) Description of Minerals and (3) Analytical Tables.

In part one, seventeen pages are devoted to some of the phenomena of light, twenty-two pages to the elements of mineralogy, and fifty-nine pages to the application of polarized light to crystalline substances. Part two contains a systematic description of all the rock-forming minerals concerning which there is sufficient data to permit their being determined by means of the microscope. These descriptions occupy 310 pages. Part three is made up of exhaustive analytical tables for determination, microscopically, of rock-forming minerals. The tables extend over fifty-seven pages.

There are also three appendices, as follows: (1) Optical Study of Opaque Minerals—ten pages, (2) Microchemical Methods—nine pages, and (3) A Partial Bibliography—two pages.

There will be, undoubtedly, much difference of opinion among petrographers and physical crystallographers as to whether the authors have succeeded in presenting the principles and methods, fundamental to a clear understanding of the physical properties of rock-forming minerals, "concisely and clearly." To be sure, they have been treated concisely, but only in a few cases clearly. Thus, the description of the nicol prism, a thorough understanding of which is absolutely essential, is intelligible only to those who have had some previous knowledge of it and know what to expect. Certainly a beginner can obtain no clear conception of it. Furthermore, the description is not entirely accurate, as is shown by the following sentence, lines 7 to 10, page 16: "The cut faces, after polishing, are cemented together again in their original position by Canada balsam—*which has nearly the same index of refraction as the Iceland spar*" (the italics are the reviewer's).

The statement, page 8, that the most exact method of applying total reflection to the determination of the index of refraction is the Kohlrausch method, is misleading, as any one who has had experience in applying it knows. Line 9, page 9, should read "the axis of the observing telescope *OT* is the line of the *reflected* ray," instead of the incident ray. Fig. 3*c*, accompanying this description, is poorly executed, the line *ON* being by no means normal to the plate *OD*. In fact, many of the

drawings are not up to the usual standard, especially that set by German writers.

In the discussion of the elements of mineralogy a brief review of the essentials of crystallography is undertaken. It would seem that altogether too much space is given over to the calculation and projection of crystals and not enough emphasis placed upon a mastery of their general morphology. For after all, the petrographer is far more concerned about the general features of crystal form, as revealed in the thin section, than he is about the calculation to the fourth decimal place of the elements of crystallization.

In the chapter on the application of polarized light to crystalline substances the optical behavior and methods of determination of crystals are treated. In too many cases are the phenomena, to be observed, described without any attempt being made to explain them. This is especially the case with the discussion of the formation of uniaxial interference figures. The statement on page 46, "The student must keep in mind the principles of polarization of light as given in Chapter II.," needs to be corrected, as polarization is not at all referred to in the chapter indicated.

Parts two and three are the most important features of the text. The descriptions of the various minerals are in all cases full and include, aside from a discussion of the crystallographic, optical and other physical properties, paragraphs treating inclusions, recurrence, diagnostics and classification. Many figures showing the optical orientation accompany these descriptions. The discussion of the feldspar group is very exhaustive, covering forty-seven pages and including fifty-four figures. The analytical tables are well arranged and usually lead to a rapid and accurate determination of the mineral under consideration.

Although the authors have failed to present the principles and methods of optical mineralogy in a manner which will allow of a ready comprehension by the beginner, they have nevertheless succeeded in making easily accessible the more important data of rock-forming minerals. This feature alone is sufficient to commend the book to the use of advanced students of petrography and physical crystallography.

EDWARD H. KRAUS
MINERALOGICAL LABORATORY,
UNIVERSITY OF MICHIGAN

Gold: Its Geological Occurrence and Geographical Distribution. By J. MALCOLM MACLAREN, D.Sc. Cloth, 6 × 10 ins., pp. 687. London, The Mining Journal.

Maclaren's "Gold" is a recent acquisition to a somewhat overworked field of endeavor. The work has been compiled, as such works must needs be, through much painstaking effort extending over a number of years; an important consideration being that a large part of the information presented has been verified by investigations made by the writer which add weight and authority to the statements.

The book is divided into two parts, namely, the General Relations of Auriferous Deposits and the Geographic Distribution of Gold. In the first part is a general discussion of the occurrence of gold, including a general statement regarding the structure of the earth and its relation to ore deposits. There is a brief discussion concerning the zone of fracture, sources of metallic ores and underground waters, filling of fissures, secondary enrichment, etc., but it is doubtful whether they should not have been discussed at greater length or not considered at all.

There is an interesting section devoted to a discussion of the physical and chemical characters of gold, its alloys and natural compounds.

The geological occurrence of auriferous deposits is taken up under the head of Classification of Deposits, which is divided into two groups, the primary and secondary, the occurrence by countries, districts, etc., being considered under these heads. It is needless to say that an attempt to cover the occurrence of gold throughout the world in seventy odd pages is much too big a task to be done comprehensively.

The bulk of the book is devoted to a discussion of the geographical distribution of gold, and while fairly exhaustive leaves much

to be desired from the standpoint of details, and details which are essential to a clear and comprehensive discussion of the localities in which gold is found and its associated minerals.

The book is well written, and while it contains much of interest it is doubtful whether it fills any great and pressing need which is not already occupied by other works. An important and valuable feature is the comparatively large number of references embodied in the text to which the reader may turn for verification of stated facts or to extend his information. Its chief value lies in the fact that the occurrence of gold is given for the whole world and not for some particular country. To those who enter upon the study of precious metals, a keen regret must be experienced in the perusal of such a work, that both of the precious metals, gold and silver, could not have been considered together, owing to their intimate association in ore deposits and their relations to commerce and industry in the world's community. In many respects this work is a valuable addition to the literature on the occurrence of gold, and will be welcomed by many.

Walter R. Crane

SCIENTIFIC JOURNALS AND ARTICLES

The June number (volume 15, number 1) of the *Bulletin of the American Mathematical Society* contains the following papers: Report of the April meeting of the society, by F. N. Cole; Report of the April meeting of the Chicago section, by H. E. Slaught; "A Set of Criteria for the Summability of Divergent Series," by W. B. Ford; "On Fredholm's Equation," by P. Saurel; "The Chicago Symposium on Mathematics for Engineering Students," review by H. W. Tyler; "Osgood's Calculus," review by C. N. Haskins; "Shorter Notices": Bachmann's Grundlehren der neueren Zahlentheorie, by J. W. Young; Whitehead's Axioms of Descriptive Geometry, by F. W. Owens; Jouguet's Lectures de Mécanique, and Andoyer's Cours d'Astronomie, by W. R. Longley; "Notes"; "New Publications."

The July number (concluding volume 15) of the *Bulletin* contains: "Tautochrones and Brachistochrones," by E. Kasner; "Degenerate Pencils of Quadrics connected with $\Gamma^{n+2}_{n+4,n}$ Configurations," by W. B. Carver; "On the Use of n-fold Riemann Spaces in Applied Mathematics," by J. McMahon; "Mathematical Appointments in Colleges and Universities," by E. J. Wilczynski; Picard's Algebraic Functions of Two Variables, review by J. I. Hutchinson; "Shorter Notices": Correspondance d'Hermite et de Stieltjes, by James Pierpont; Scott's Cartesian Plane Geometry, Part I., Analytical Conics, by E. G. Bill; Hilbert's Grundlagen der Geometrie, third edition, by A. R. Schweitzer; Klein-Schimmack, Vorträge über den mathematischen Unterricht an den höheren Schulen, Part I., by J. W. A. Young; "Notes"; "New Publications"; "Eighteenth Annual List of Papers read before the Society and Subsequently Published"; Index of Volume.

SPECIAL ARTICLES

DIPLODIA DISEASE OF MAIZE (SUSPECTED CAUSE OF PELLAGRA)

For about two years the writers have been studying the *Diplodia* disease of corn now serious in some parts of the country, with especial reference to its manner of infection. An examination of a bundle of maize plants sent from the west in 1907 indicated pretty clearly that the infection of the cobs was from within, *i. e.*, from the interior of the stem by way of the root system, and not simply a local attack as hitherto supposed. The mycelium was found in all the inner parts of many stems from roots to cobs and in the interior of the latter, and the kernels were moldy (white).

In February, 1908, pot experiments were started in one of the hothouses to verify this inference, the soil being inoculated with pure cultures of the fungus. On June 2 in one of the pots the *Diplodia* was found fruiting on the roots and at the base of the stem, and the mycelium of the fungus was found in the interior of the root, stem and cob in abun-

dance, but not anywhere on the *surface* of the plant except at its base. The mycelium extended upward inside this stem two thirds of its length. On another plant in this pot *Diplodia* was also found in fruit on the crown, and the mycelium was present in the interior of the stem but did not extend upward for any distance.

On the same day in another pot the mycelium was found in the parenchyma and bundles of the roots of one plant. Pieces of the roots were put into damp chamber and in five days the pycnidia of *Diplodia* appeared in great numbers.

The same day in a third pot the mycelium of *Diplodia* was found not only in the interior of the roots but also in the interior of the first two internodes of the stem, from which pure cultures of it were obtained. Here again it was not present on the surface.

The next day in a fourth pot *Diplodia* was found fruiting on the stem in the first four internodes as a result of the presence of internal mycelium. This mycelium was also demonstrated in the interior of the fifth internode, and pure cultures of it were obtained from the interior of this stem. Generally the pycnidia were most abundant at the nodes. They occurred also on the leaf sheaths.

The following summer (1908) the experiment was repeated in a plot out of doors by means of soil inoculation with pure cultures, but, owing to a late start and the fact that the plants had to be dug up early to make room for a new building, the experiment was a failure, except that there were indications of infection in the basal nodes and internodes of two plants. Experiments are under way again this summer.

There seems little doubt that the manner of infection indicated is the common one, *i. e.*, from the soil into the roots, from these to the interior of the stems, and thence upward to the cobs, and finally to the kernels, but it is not unlikely that certain soil conditions may favor or hinder the root infection. This remains to be worked out. Unquestionably the *Diplodia*, like the *Fusarium*, is a soil organism persisting from year to year in infected fields, which for this reason should be staked off and planted to other crops than corn.

It is also worthy of inquiry whether this fungus may not be the cause of the so-called "cornstalk" disease prevalent among cattle in the west. It is also possible that to *Diplodia* should be referred the great numbers of deaths of negroes in the south during the past three years from the so-called pellagra, following the consumption of moldy cornmeal and moldy hominy. This fungus (*Diplodia*) is also a cause of moldy corn in Italy. The only other fungi we have reason for suspecting in this connection are species of Aspergillus. The writers would be very glad to receive for study samples of hominy or corn meal suspected of being the cause of pellagra.

ERWIN F. SMITH,
FLORENCE HEDGES
LABORATORY OF PLANT PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.,
July 23, 1909

SOCIETIES AND ACADEMIES

THE GEOLOGICAL SOCIETY OF WASHINGTON

AT the 218th meeting of the society, held at the Cosmos Club, on Wednesday evening, April 14, 1909, Mr. David White presented as an informal communication some notes on the "Kent Coal Basin of Southern England." Calling attention to Professor E. A. Newell Arber's paper in the February number of the *Journal of the Geological Society of London*, in which the fossil plants from the deep drillings near Dover, England, are described, he pointed out that the three workable coals, 1,881–2,377 feet deep in the Waldershare core, are paleobotanically either Mercer or Clarion in age, probably the former, though both ages may be represented. The boring about 6 miles farther south, on the coast, cuts 13 coals between 1,100 and 2,270 feet, in a more arenaceous series, also of older Pennsylvanian age. The drillings therefore indicate a considerable number of workable coals in the basin (Kent) passing beneath the Channel at Dover.

Regular Program

Débris Tracks on the Domes of the Yosemite Region: Mr. F. E. MATTHES.

The Yosemite landscape is characterized by many large expanses of smooth, bare granite. Over these different things move or have moved at various times: water in sheets, rills and streams, snow and glacial ice, and with each of these carriers, rock débris in varying quantities and states of comminution. As a consequence these rock surfaces are scored, marked and striped in sundry ways. The nature of these different markings is well understood; yet there is one kind among them that appears scarcely to have received recognition, namely, that produced by creeping rock débris. It is on gently inclined surfaces, such as obtain on the crowning portions of the Yosemite domes that the conditions are most favorable for their development. Loosened rock fragments here slide or creep down at the rate of perhaps but a few inches annually. The frictional resistance of the smoothly curved granite surface being very slight, but little force is required to propel the fragments in downward direction. Probably a number of agents are involved, but snow and water no doubt furnish most of the necessary energy. As the fragments advance they leave trails or tracks behind, conspicuous by their whitish color. Close inspection reveals that these consist simply of paths from which the lichens and mosses that cover the rock surface everywhere and give it its subdued grayish tint have been cleared off. So slow is the progress of the débris, however, that the removal of the lichens can obviously not be attributed to mechanical abrasion. Picking up a fragment one finds its base invariably embedded in a pad of loose rock grains. Now lichens can not live under even the thinnest film of sand. The explanation therefore seems to be that the pad of sand grains kills the lichens under it, and as it moves along with the larger fragment, leaves a clean swath behind. The process is evidently as effective on a small scale as on a large one. On the little-frequented slopes of Liberty Cap and the other lesser domes of the upper Yosemite region, where the débris has a chance to travel year after year, undisturbed by man or animals, rocks of every size down to that of a pea were observed, each at the lower end of a whitish track of proportionate width. Some of the tracks were but a few inches long, but many of them measured several yards. On a bared portion of the rock floor of the Little Yosemite Valley the phenomenon is revealed on a grand scale and wholesale fashion. Several acres of smooth granite here appear blotched, as it were, with a multitude of long whitish stripes and streaks. The débris by which the latter were produced, however, has long since vanished and the rock floor has now a clean-swept look. The cause of the disappearance of the débris may be inferred from the character of the tracks. The latter frequently fork downward, once or several times in repetition. The rock fragments, probably of glacial origin to begin with, must have disintegrated on the way, falling apart in successively smaller pieces, until at last they were resolved into little heaps of loose rock grains that were easily swept away.

Observations on the Recent Calabrian Earthquake: Mr. C. W. Wright.

This paper was published in the *National Geographic Magazine* under the title of "The World's Most Cruel Earthquake," and no abstract is therefore given here.

At the 219th meeting of the society, held at the Cosmos Club, on Wednesday evening, April 28, 1909, Mr. David White presented an informal communication on "Graphic Methods of Representing the Regional Metamorphism of Coals." He exhibited a map covering a portion of the Appalachian trough on which the fixed carbon of the coals (ash and moisture free) was platted according to the location of analyzed samples and contours were drawn showing the degrees of devolatilization in passing from the western margin of the coal field to the Anthracite regions. This method not only shows successfully the progressive devolatilization, as the result of deep-seated thrust pressure, of the coal, the greatest alteration marking the greatest pressure, but it also illustrates the fact that folding and faulting, though valid as proof of thrust action, did not always attend the greatest devolatilization, since they, in some instances, undoubtedly gave relief from long continuance of possible maximum pressure, while pressures, perhaps lower but exerted for a longer time, without relief by plication, in contiguous areas, effected greater changes in the fuel. The method was recommended as direct, without recourse to ratios, and simple, being based on proximate analyses. It illustrates in a striking way the improvement of the bituminous coals as the result of regional metamorphism. A similar platting and "contouring" for the same area, of the carbon-oxygen ratios (dry coal, the oxygen compensated for sulphur) show these contours not only to conform in general to the fixed carbon contours, but also better to express the regional changes in the "heat value" of the coals.

Regular Program

Geology of the Mexican Oil Fields: Mr. C. W. HAYES.

Geology of the McKittrick-Sunset District, California: Mr. H. R. JOHNSON.

The Temblor Range, along the northeast slopes of which the McKittrick, Midway and Sunset oil fields of California are located, includes, besides a limited amount of granitic and metamorphic rocks of pre-Cretaceous age, unaltered sedimentaries of Cretaceous, Tertiary and Quaternary age. Briefly the formations comprising the unaltered sedimentary series are as follows:

Knoxville-Chico (Cretaceous) Sandstone.—These include between 7,000 and 12,000 feet of dark green, well laminated and usually nodular shales with intercalated sandstones which predominate in the upper portion of the series. Some of the sandstone includes zones of hard chocolate brown nodules of considerable size, which give the beds an appearance typical of the Cretaceous in the region. The Cretaceous was probably deposited upon an eroded surface of the pre-Cretaceous metamorphic complex known as the Franciscan formation in the Coast Ranges.

Tejon Sandstone (Eocene).—This series of yellowish brown somewhat nodular sandstone with a small amount of intercalated clay shale reaches a maximum thickness of about 2,500 feet. It extends from the Devils Den and Antelope Valley region southeast with considerable continuity along the northeast flank of the range nearly to Temblor Ranch. Although a non-conformity between the Tejon and Knoxville-Chico series is known to exist, there is little field evidence of this condition in the region.

Wagonwheel Formation (Oligocene?).—This is a local occurrence of sandstones and several layers of white diatomaceous shales which appear to be of Oligocene age upon paleontologic evidence. If this determination is correct it marks the first discovery of marine Oligocene in the San Joaquin Valley of California. The beds are located in the isolated group of hills south of Bartons and northeast of the Point of Rocks in the Devils Den District.

Vaqueros (Lower Miocene) Sandstone.—This is a fairly continuous and usually easily recognizable massive yellow sandstone including a couple of fossiliferous reefs which, because of their superior hardness, are easily traceable for long distances. The formation is well distributed over the field and is of variable thickness, its maximum probably being east of Annette, where over 2,000 feet has been measured. Elsewhere the formation is less than 100 feet thick.

Monterey (Lower Middle Miocene) Shales.—Characteristic areas of this siliceous and calcareous formation exist at a number of points in the region. The largest of these areas occupies the bulk of the Temblor Range from west of Temblor Ranch southeast to the limit of the region studied. It is exposed on either flank of the range for a number of miles northwestward from this mass and overlies the Vaqueros sandstone conformably. The maximum thickness measured, in which, however, the beds may be doubled by close overturned folding, is about 4,000 feet, a thickness considerably less than the Monterey at other points in the state. At the base of the Monterey there are beds of sandstone transitional into the Vaqueros and at several horizons in the formation similar sandstone lenses occur. In a general way it may be stated that the lower half of the Monterey includes a higher proportion of calcareous and siliceous shales than the upper part, in which the diatomaceous facies becomes more prominent.

Santa Margarita Formation.—This formation includes rocks of considerable variety, but along the northeast flank of the Temblor Range heavily bedded diatomaceous shales are characteristic of it. While the formation rests unconformably upon the Monterey there is little difference in dip between the two series, and except for greater hardness in the older and the predominance in portions of the field of diatomaceous shale in the younger formation, there is slight stratigraphic basis for their separation. Southwest of Midway the characteristic diatomaceous shales of the Santa Margarita are intercalated with lenticular beds of heavy granitic material which offers striking contrast to the very fine organic shales with which they are associated. The great difference in texture and origin of these two facies is indicative of remarkable topographic or climatic oscillations during the period of deposition of the Santa Margarita, and presents an interesting question for future solution. The total thickness of the Santa Margarita is about 1,500 feet.

Etchegoin-Jacalitos Formation.—This term has been rather loosely applied in the field to a series of clays, soft shales, gravels and loosely consolidated sands which lies unconformably above the Santa Margarita. It is of wide distribution throughout the region and its uppermost beds are the latest to have suffered deformation. Its thickness is very variable but the maximum may be stated as about 2,000 feet, although upon the

southwest side of the Temblor Range a thickness of 3,700 feet has been measured.

Quaternary Deposits.—The fluviatile sands, clays, soils and gravels which are the results of erosion since the latest deformation in the region, have been included under this head. Exception to the above statement must be made with regard to some of the gravels along the San Andreas fault line, upon which movement and resulting deformation have taken place even within historic times. Such a classification will exclude all except the stream alluvium and fine material skirting the range and some of the gravel remnants left upon the canyon slopes above the present drainage lines. Along the margin of the San Joaquin Valley there is the usual type of fine material, a result of the coalescence of detritus from a number of sources. Some small valleys of Quaternary material lie at several points within the mountain ranges but except in the larger examples the material has not been mapped.

Structure.—The structure of the McKittrick-Sunset region is very complicated. In general, the range may be considered as a block faulted upward along either side at such a recent date, geologically speaking, that the escarpments so produced have been well preserved. Accompanying this faulting were developed a number of major anticlinal structures, the axes of which are not exactly parallel with the axis of the range, but diverge from it at a low angle toward the southeast. The result of this folding has been to produce a number of prominent salients extending southeasterly away from the main range. Toward its southern extremity the structure of the Temblor Range is affected by the Tehachapi uplift. This is well exemplified in front of McKittrick in the Elk and Buena Vista hills, the structural axes of which swing toward the east and at some places are almost at right angles to the trend of the main range. Here even more than elsewhere in the United States the structural conditions play a very important part in the accumulation of petroleum, and in consequence the folds and faults have been studied and mapped with considerable care, especially in the Sunset, McKittrick and Midway fields; special maps having been prepared which indicate the relations between the structure and the oil developments already made.

Oil Resources of the McKittrick-Sunset District, California: Mr. Ralph Arnold.

Francois E. Matthes,
Secretary

THE NEW YORK ACADEMY OF SCIENCES
SECTION OF BIOLOGY

A regular meeting of the section was held at the American Museum of Natural History, May 10, 1909, Mr. Frank M. Chapman, chairman of the section, presiding. The following papers were read:

Bufo agua in Bermuda: Professor Charles L. Bristol.

The Relation between the Taxonomic Characters of Crickets (Gryllus) and the Environment: Dr. Frank E. Lutz.

The speaker stated that the species of *Gryllus* are distinguished chiefly by the actual and relative sizes of the ovipositor, posterior femora, wings and tegmina. The length of the ovipositor is correlated with the character of the soil, being longer on sandy soils than on the firmer ones. This is probably brought about by selection destroying the eggs which are not deeply placed in loose soil. The length of the wings seems to be a function of three variables: ancestors, heat and moisture. Increased heat and moisture are accompanied not only by an increased percentage of the long-winged dimorphs, but by a greater wing length of the short-winged group. No relation has been discovered between the size of the posterior femora and the environment. These conditions bring about marked differences between the crickets in different habitats, and these differences are of "specific" rank.

Deleterious Ingredients of Food: Dr. E. E. Smith.

It was shown in this paper that food itself is deleterious if ingested in sufficient quantity. This is not an essential quality of food, but one dependent on the quantitative relation. Any ingredient added to food is deleterious in the quantitative sense, precisely as food itself is. The statement of the Food and Drugs Act, June 30, 1906, "an article shall be deemed to be adulterated, in the case of food, if it contain any added poisonous or other added deleterious ingredient which may render such article injurious to health" is to be interpreted as referring to ingredients that are essentially deleterious. Substances that serve a useful purpose in amount widely separated from the quantity that may produce injurious effects are not essentially deleterious, even though they may become deleterious by abuse of the quantitative relation.

Frank M. Chapman,
Secretary pro tem.